Development of Water Quality Standards for Willard Spur

Hydrology & Nutrient Loads

2011 – 2012

Referencing draft memorandum dated January 21, 2013

January 28, 2013

Willard Spur Science Panel

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Hydrology

- **What are the hydrologic characteristics of Willard Spur?**
  - Inflows & Outflows
    - *Outflows measured twice – reflected inflows very well*
    - *Outflows governed by inflows, “natural weir”, and GSL water level*
    - *“Natural weir” appears to be at 4201.8ft*
  - Water levels
- **Does the Plant flow reach WS?**

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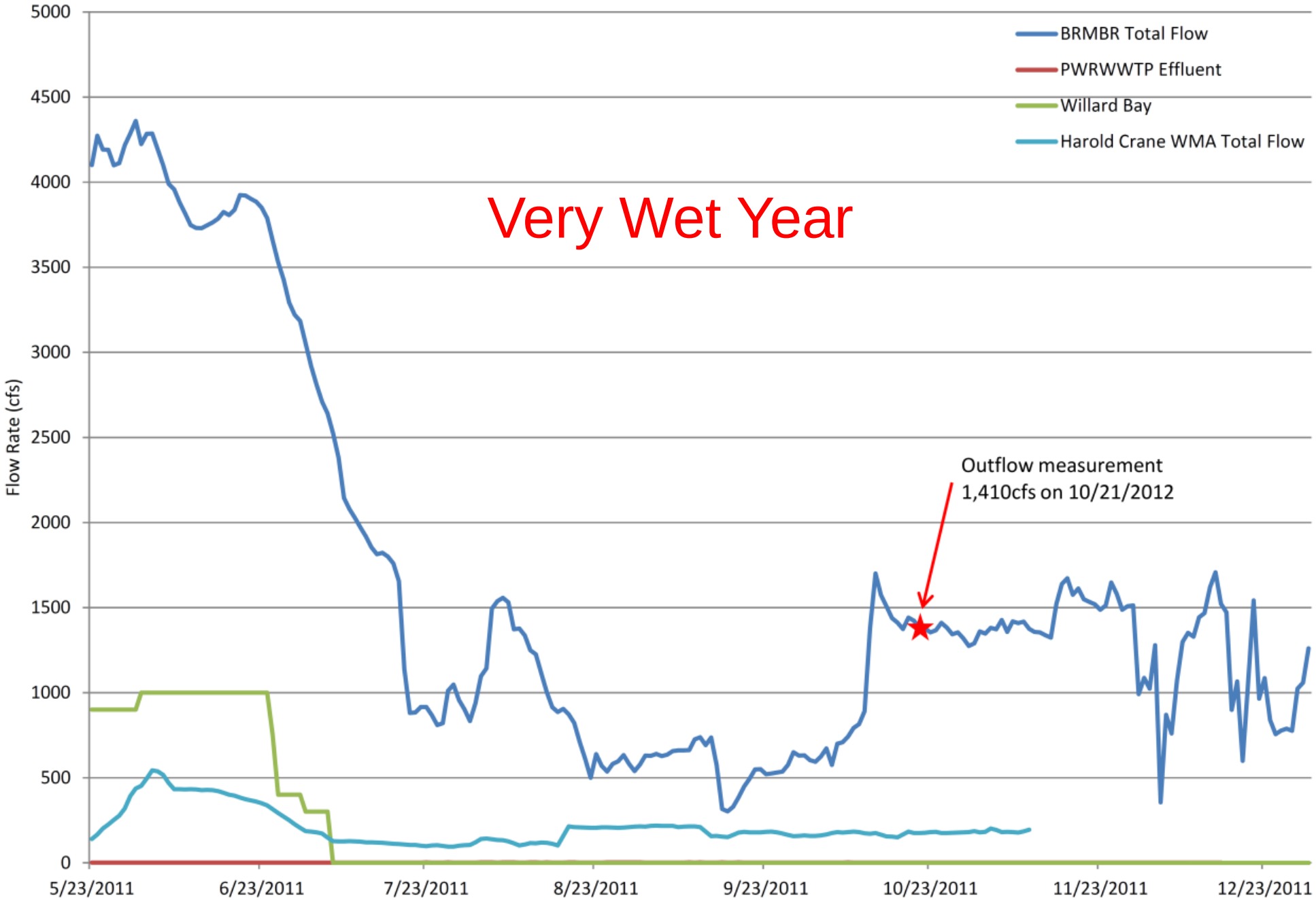
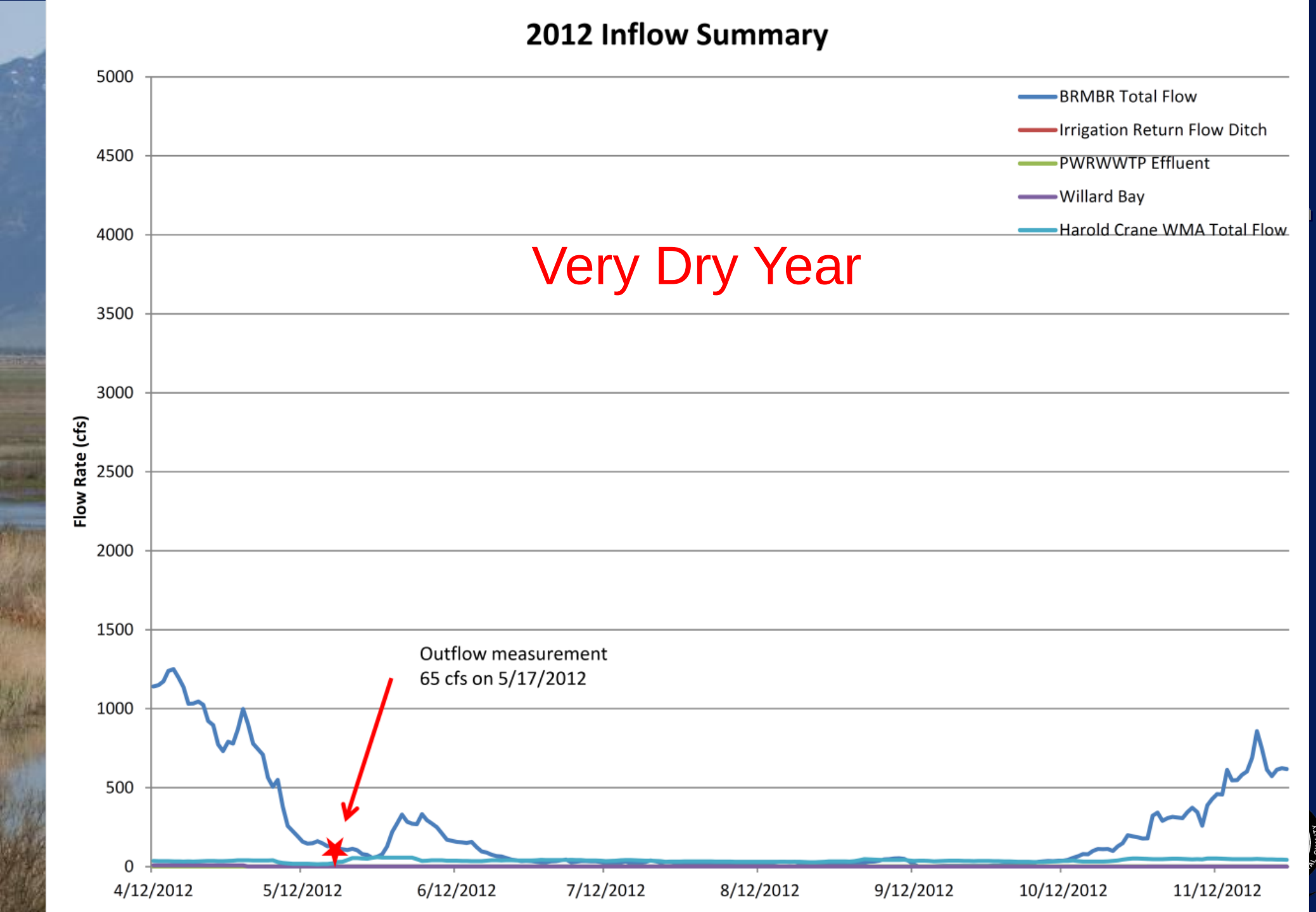
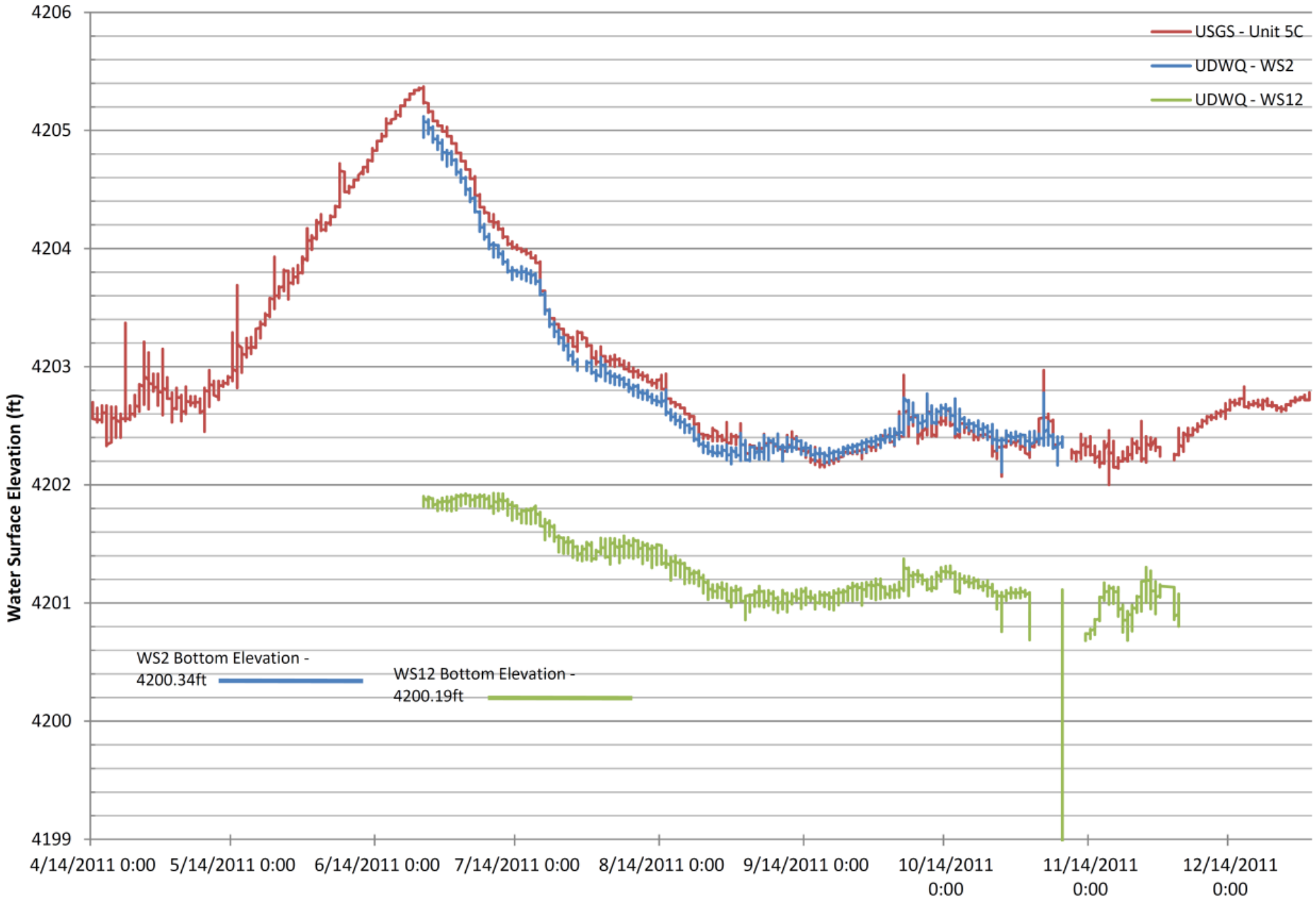
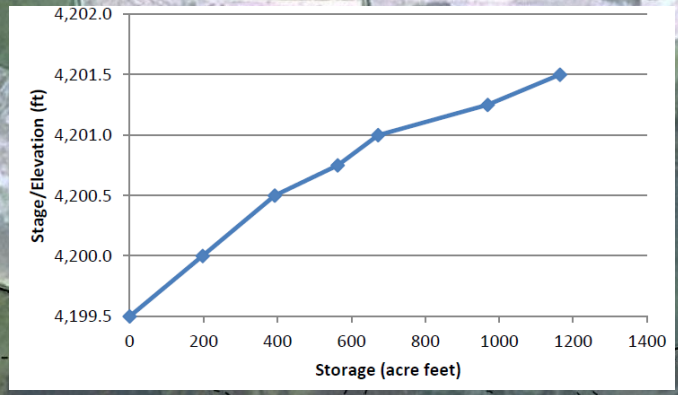
2011 Inflow Summary




2012 Inflow Summary
Very Dry Year
Outflow measurement
65 cfs on 5/17/2012
Flow Rate (cfs)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
4/12/2012
5/12/2012
6/12/2012
7/12/2012
8/12/2012
9/12/2012
10/12/2012
11/12/2012
BRMBR Total Flow
Irrigation Return Flow Ditch
PWRWWTP Effluent
Willard Bay
Harold Crane WMA Total Flow

2011 Willard Spur Water Levels





LEGEND

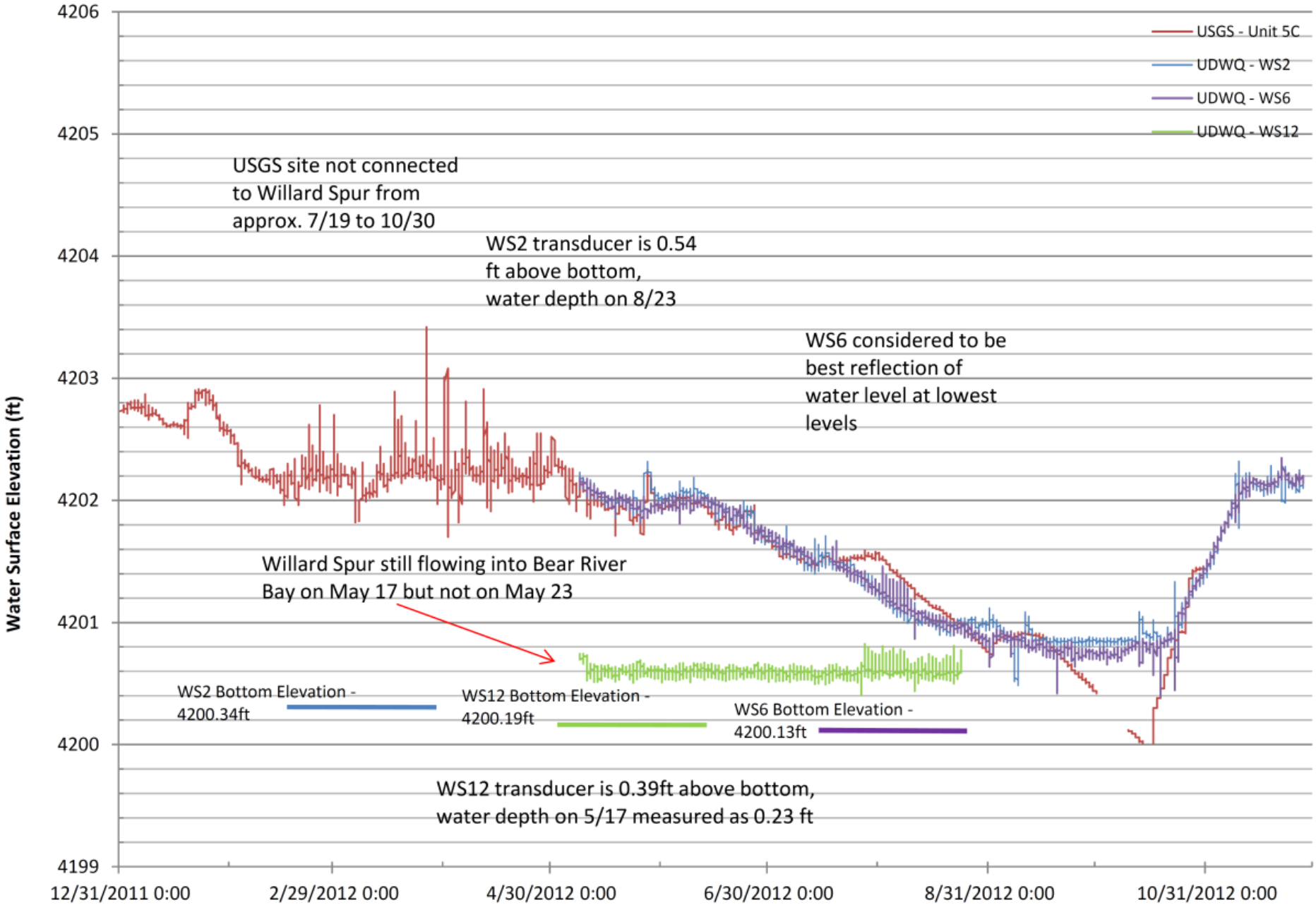
- Open Water Monitoring Site
- WS_081402 / 2932.61 Acres
- WS_081904 / 3808.65 Acres
- WS_051492 / 6181.27 Acres
- WS_072102 / 7746.9 Acres
- Elevation 4200.50 / 1570.65 Acres
- WS_4201.8 / 9874.40 Acres
- 6 Inch Elevation Contours

Notes:
Contour elevations are approximated from aerial and ground photographs and water surface elevation measurements by UDWQ and USGS in 2011 and 2012

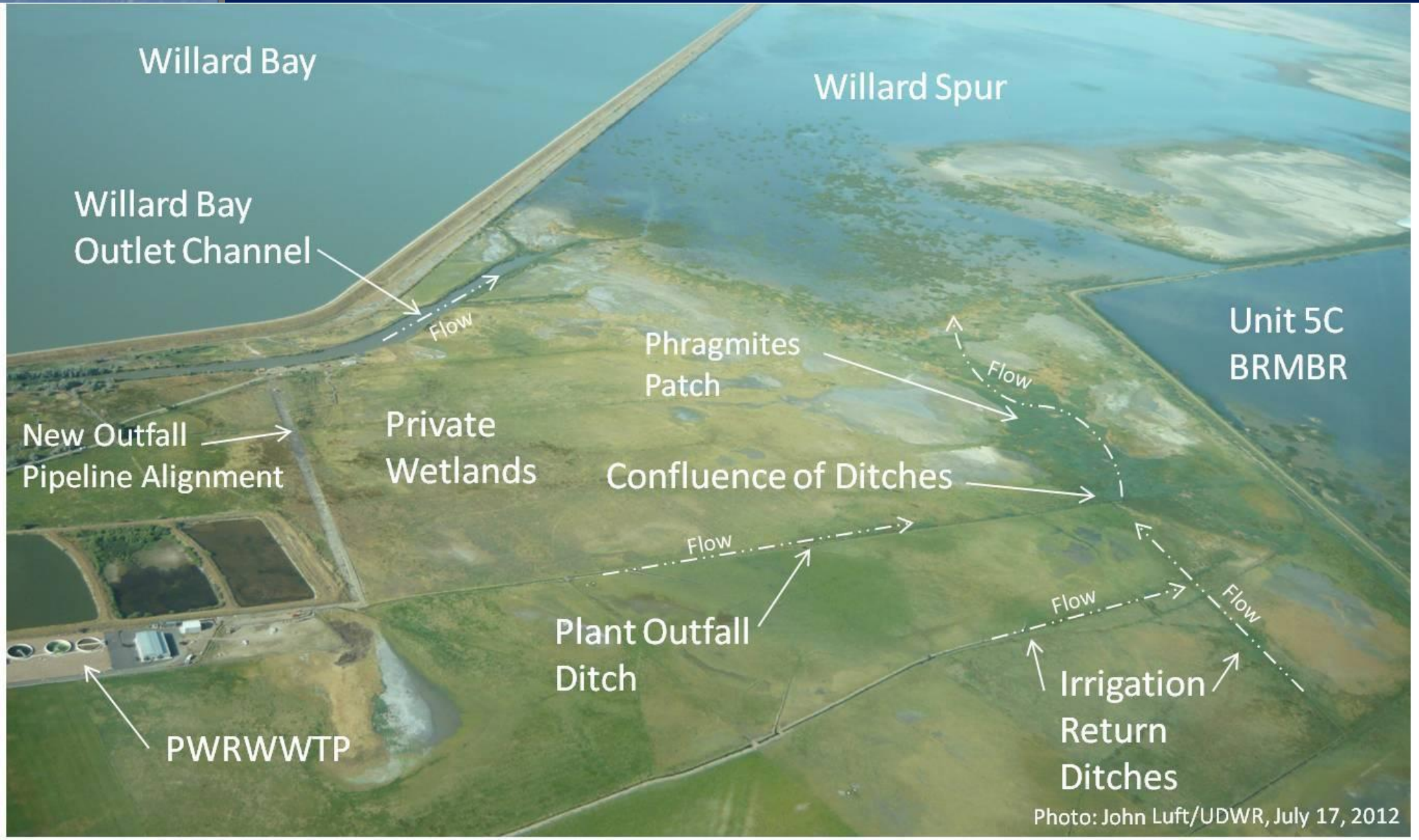
N

0 1,000 2,000
Meters

2012 Willard Spur Water Levels



When does the Plant's flow reach Willard Spur?



Summary of Plant Discharge Operations 2011 - 2012

Period of Operation	Discharge Location
April 2011 – July 26, 2012	Outfall ditch
July 27 – 29, 2012	Willard Bay outlet channel
July 30 – October 15, 2012	Outfall ditch
October 16, 2012	Private wetlands
Oct 18 – December 24, 2012	Willard Bay outlet channel
December 24, 2012 – current	Private wetlands

Source: personal communication Jeff Hollingsworth

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Nutrient Loading

- **What are the sources of nutrients entering Willard Spur and what is the relative significance of these sources?**
- Note: these pie and bar charts all assume that the full nutrient load from the Plant reaches the open water of Willard Spur. There is indication that there is uptake in the ditch/wetlands upstream of the open water as well as the effluent possibly evaporating prior to reaching Willard Spur. Thus, these comparisons of load contribution should be considered to be conservative and likely over-estimate the contribution of the Plant at this point. Work in 2013 will verify the nutrient uptake and evaporation questions and allow refinement of loads.

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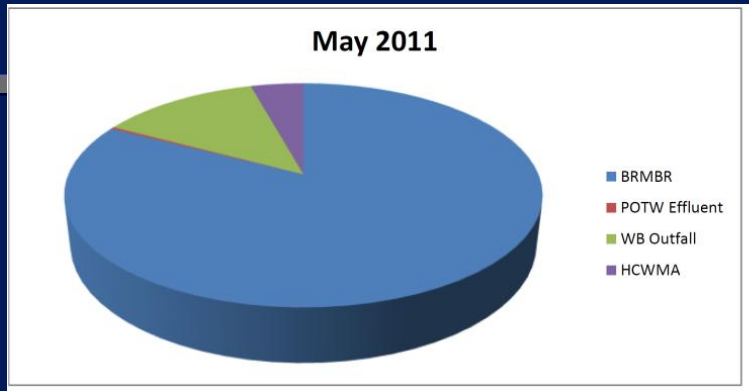
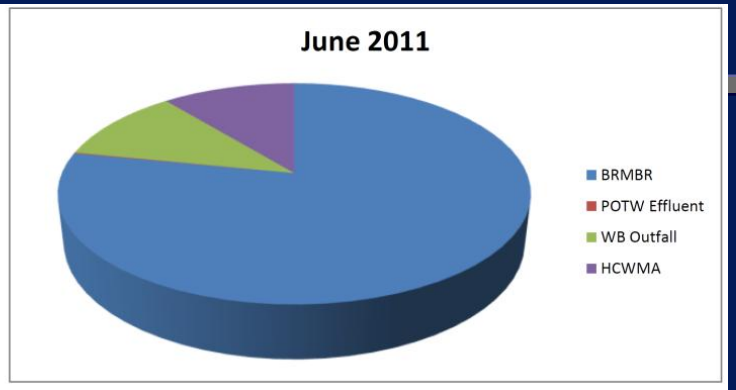
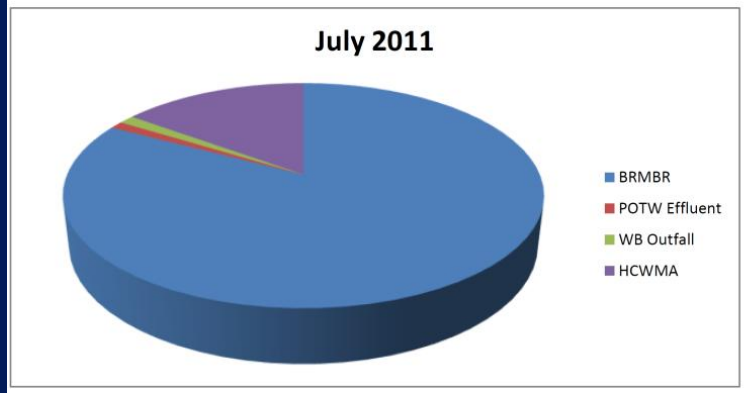
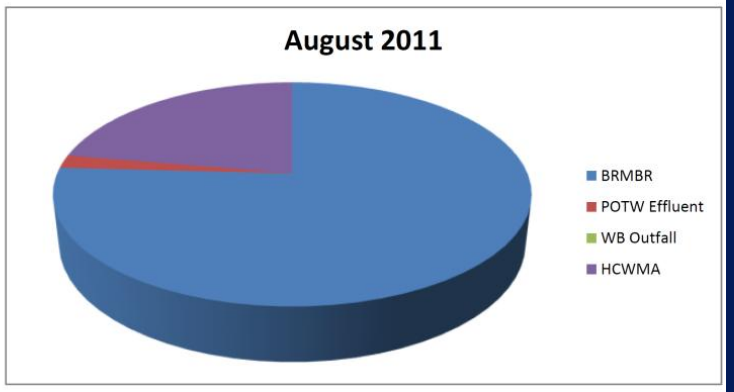
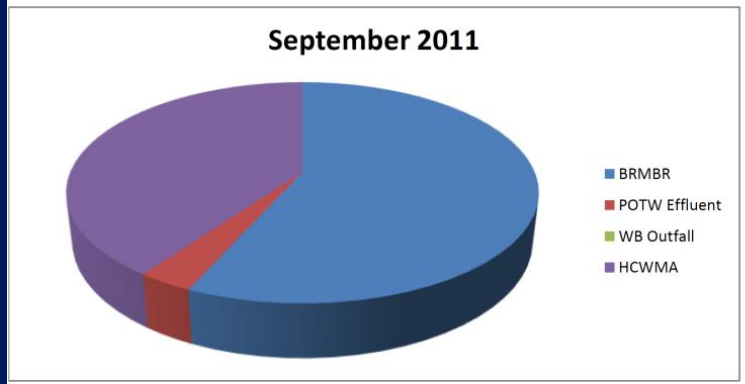
Total Nitrogen Loading - 2011

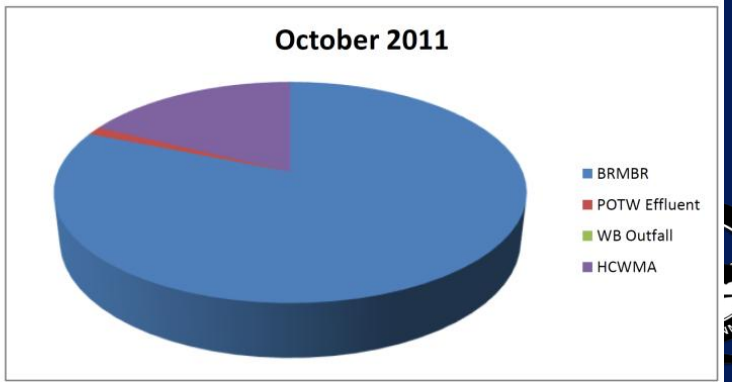




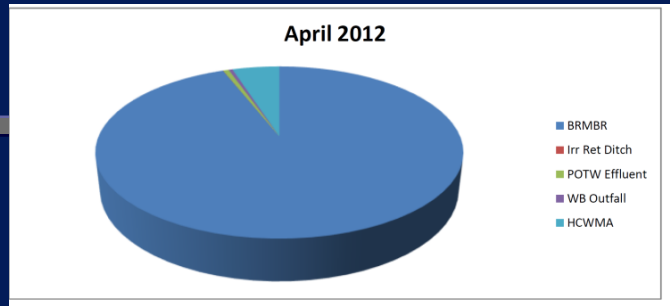


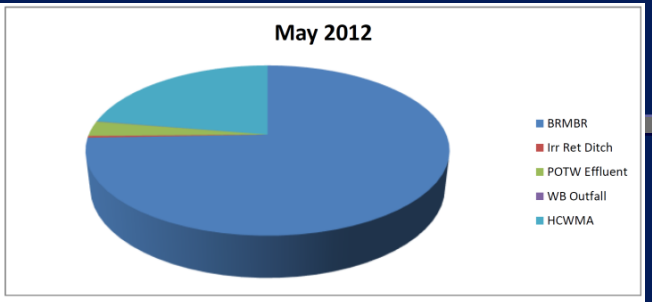


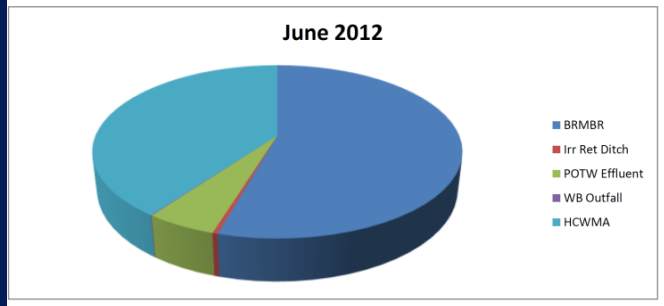


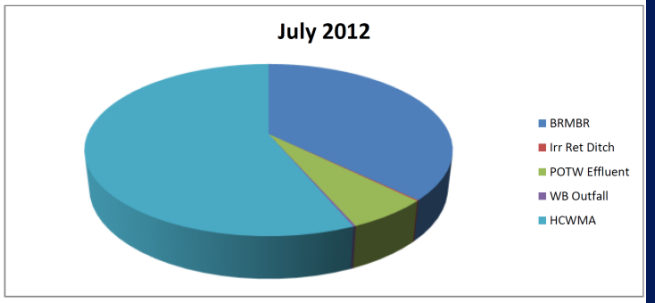


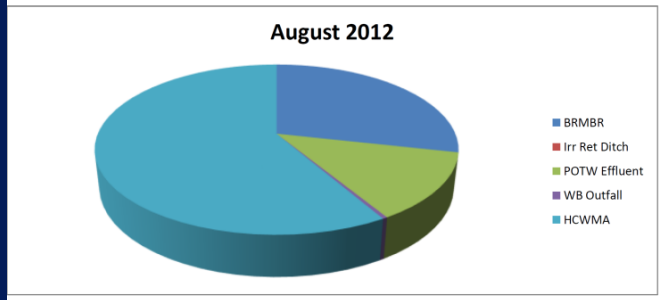
Total Nitrogen Loading - 2012

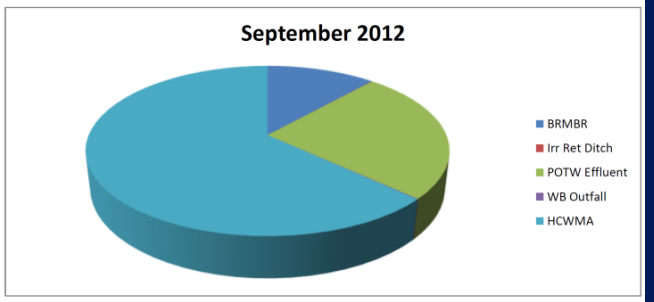


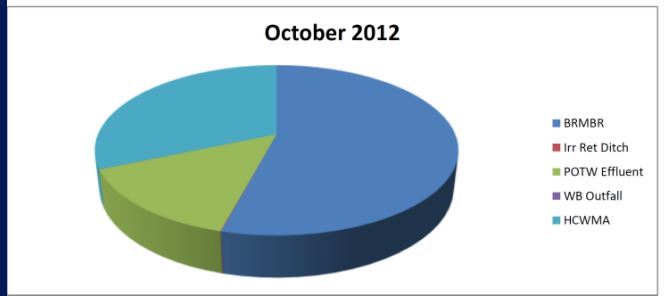


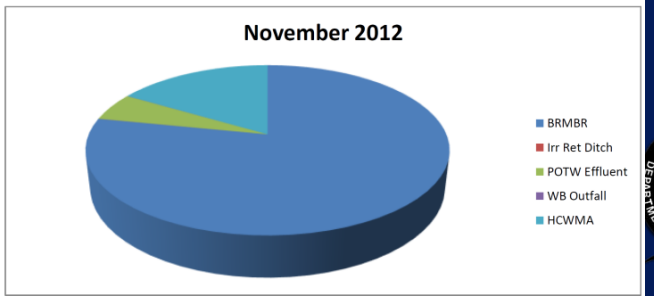




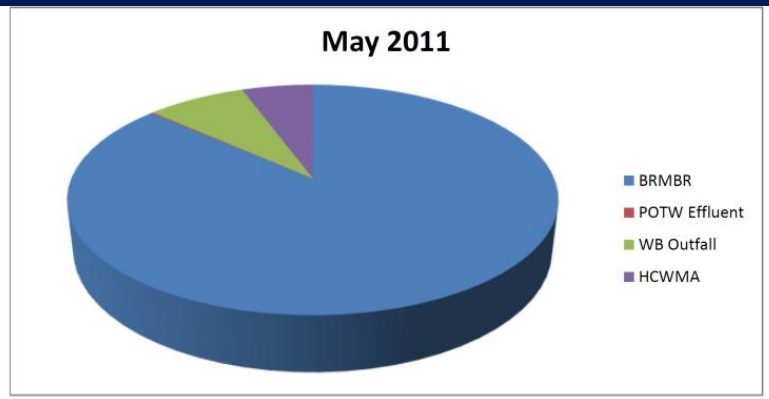


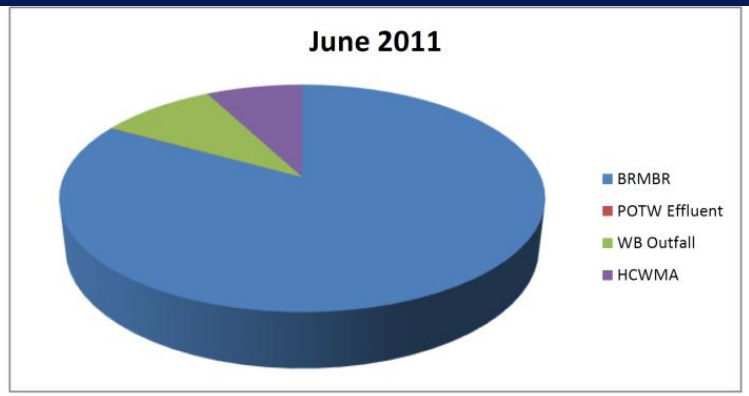


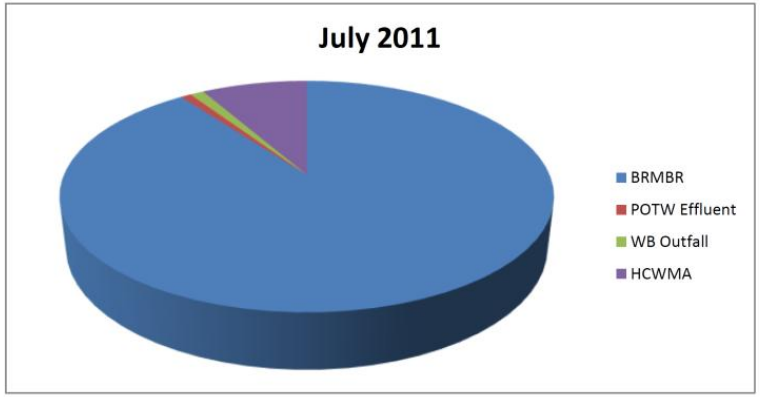


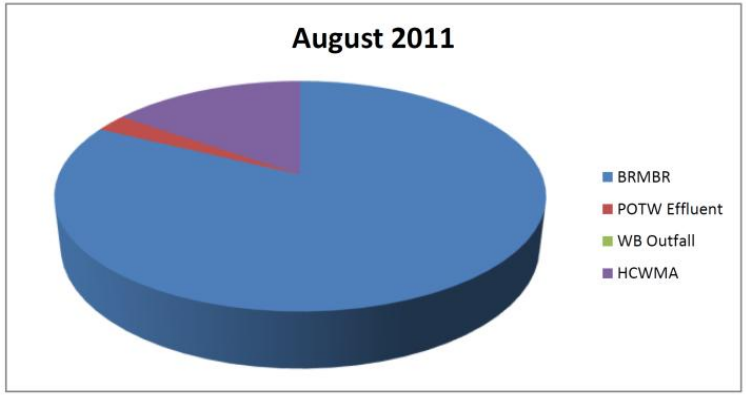


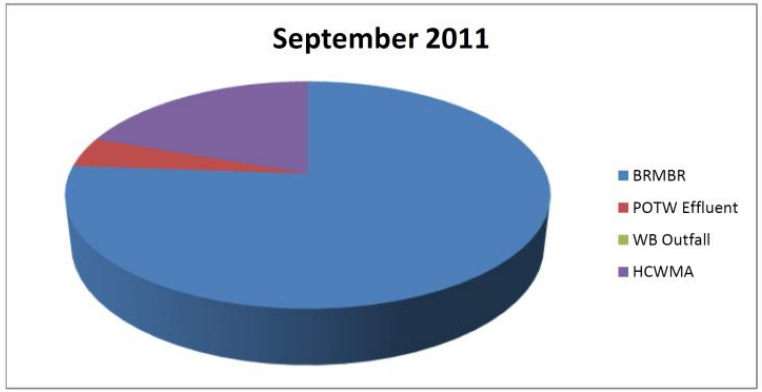
Total Phosphorus Loading - 2011

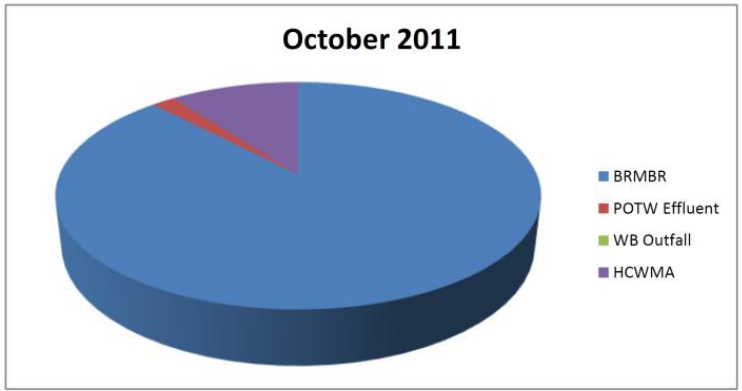




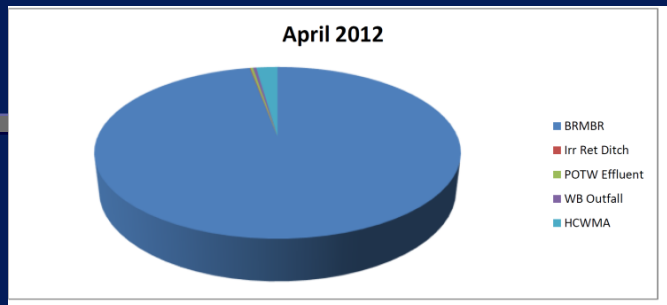


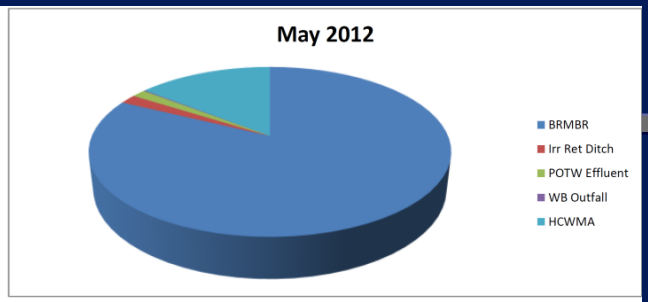


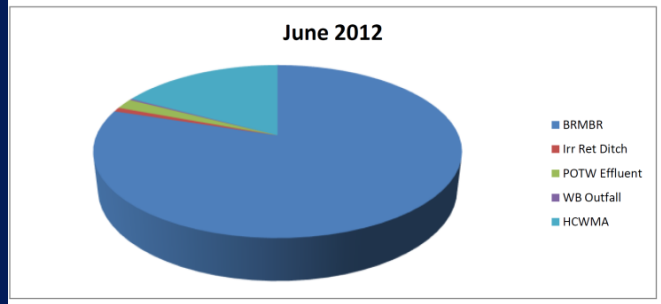


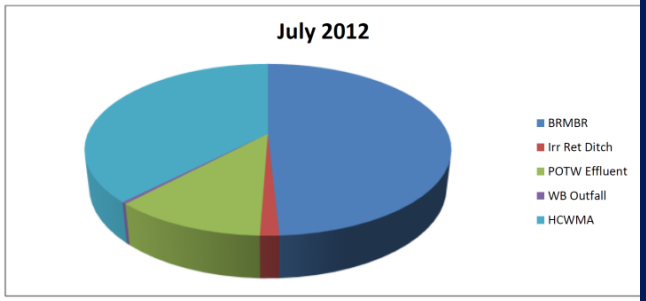


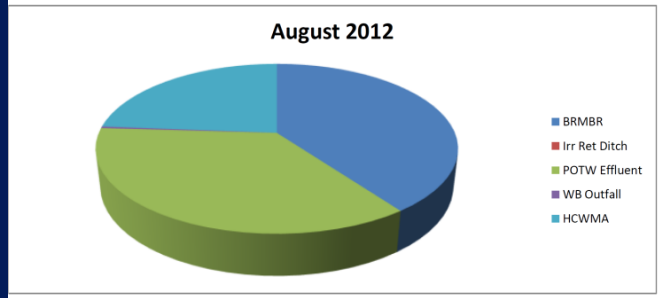
Total Phosphorus Loading - 2012

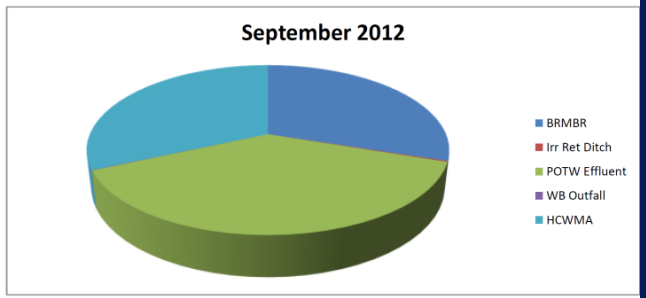


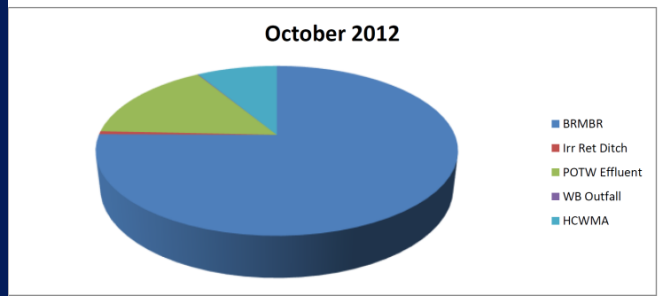


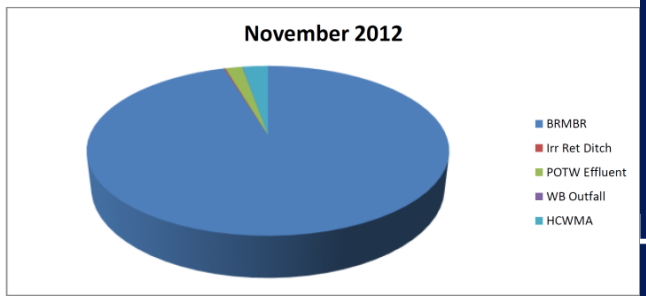












Nutrient Loading

- **What are the nutrient loads in the effluent with and without nutrient removal process at the Plant?**
- Note: these pie and bar charts all assume that the full nutrient load from the Plant reaches the open water of Willard Spur. There is indication that there is uptake in the ditch/wetlands upstream of the open water as well as the effluent possibly evaporating prior to reaching Willard Spur. Thus, these comparisons of load contribution should be considered to be conservative and likely over-estimate the contribution of the Plant at this point. Work in 2013 will verify the nutrient uptake and evaporation questions and allow refinement of loads.

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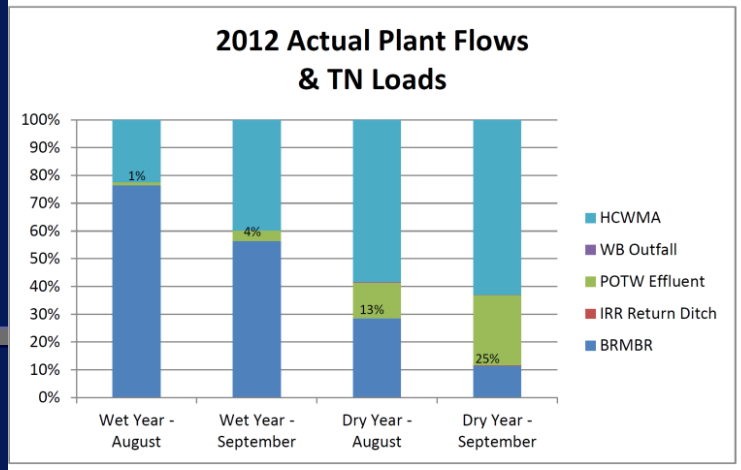
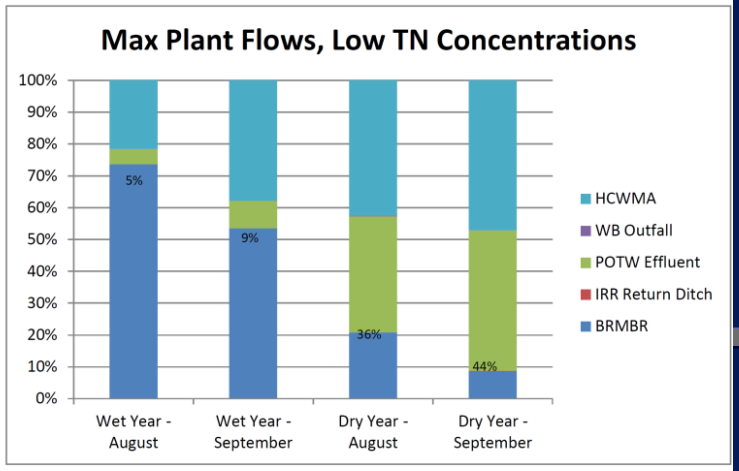
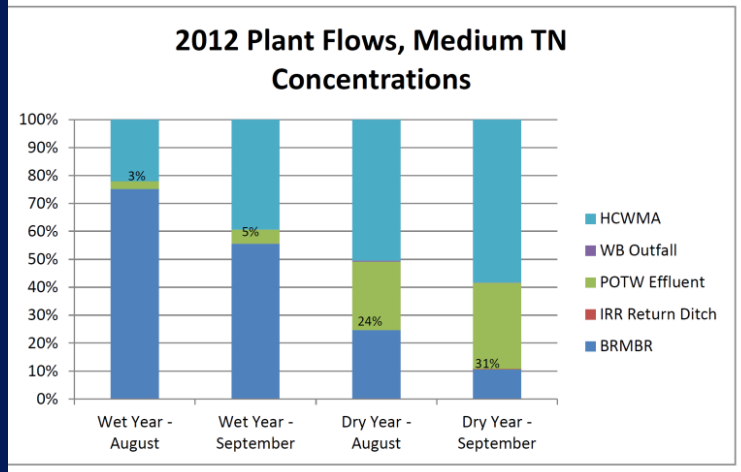
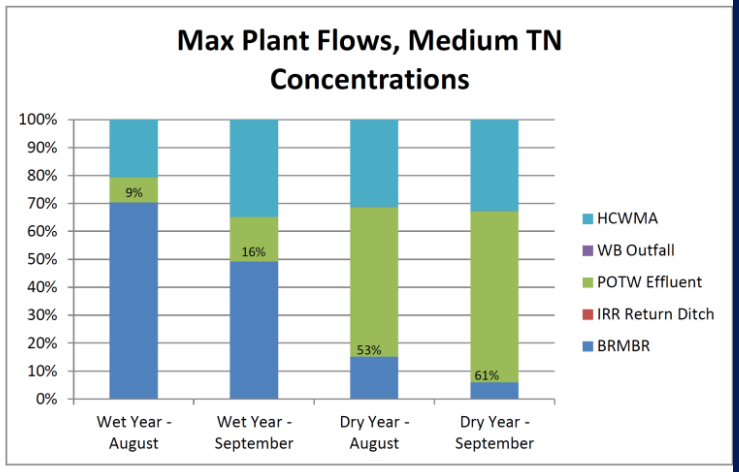
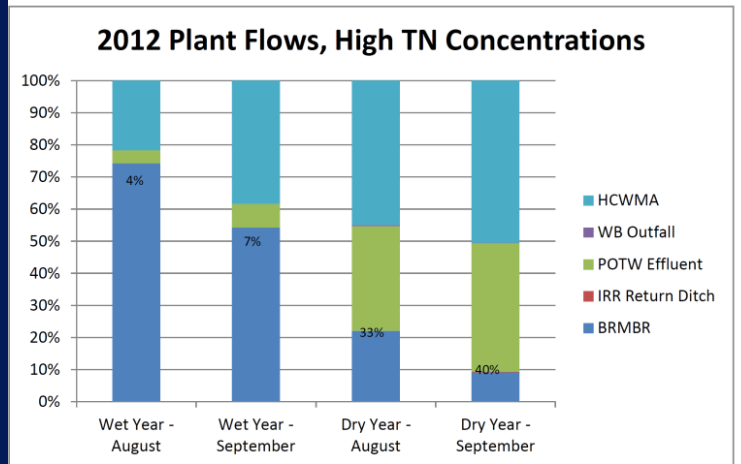
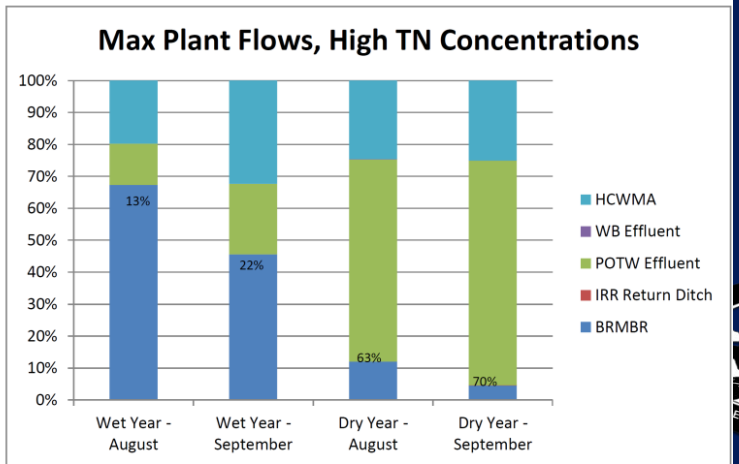

2012 Actual Plant Flows & TN Loads
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1%
4%
13%
25%
Wet Year - August
Wet Year - September
Dry Year - August
Dry Year - September
HCWMA
WB Outfall
POTW Effluent
IRR Return Ditch
BRMBR


Max Plant Flows, Low TN Concentrations
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
5%
9%
36%
44%
Wet Year - August
Wet Year - September
Dry Year - August
Dry Year - September
HCWMA
WB Outfall
POTW Effluent
IRR Return Ditch
BRMBR

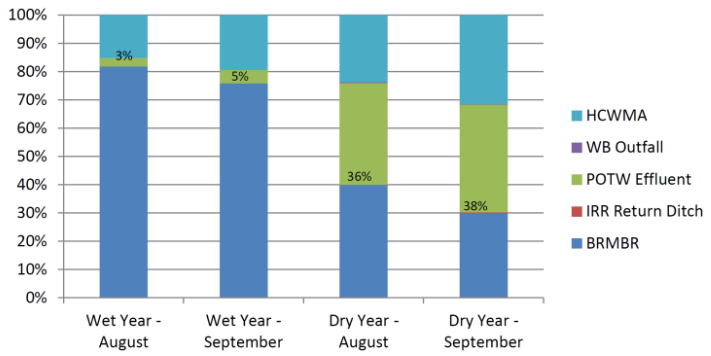

2012 Plant Flows, Medium TN Concentrations
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
3%
5%
24%
31%
Wet Year - August
Wet Year - September
Dry Year - August
Dry Year - September
HCWMA
WB Outfall
POTW Effluent
IRR Return Ditch
BRMBR


Max Plant Flows, Medium TN Concentrations
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9%
16%
53%
61%
Wet Year - August
Wet Year - September
Dry Year - August
Dry Year - September
HCWMA
WB Outfall
POTW Effluent
IRR Return Ditch
BRMBR

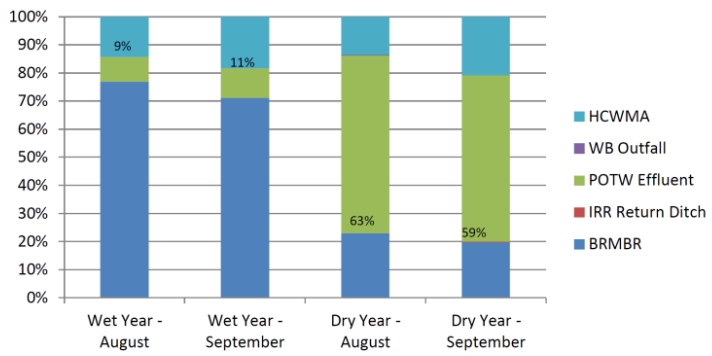

2012 Plant Flows, High TN Concentrations
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
4%
7%
33%
40%
Wet Year - August
Wet Year - September
Dry Year - August
Dry Year - September
HCWMA
WB Outfall
POTW Effluent
IRR Return Ditch
BRMBR


Max Plant Flows, High TN Concentrations
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
13%
22%
63%
70%
Wet Year - August
Wet Year - September
Dry Year - August
Dry Year - September
HCWMA
WB Effluent
POTW Effluent
IRR Return Ditch
BRMBR

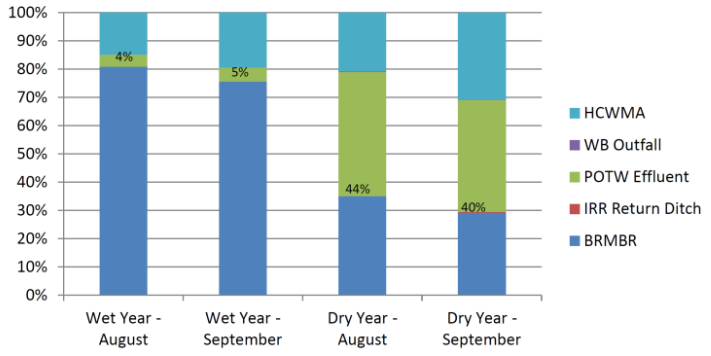
2012 Actual Plant Flows & TP Loads



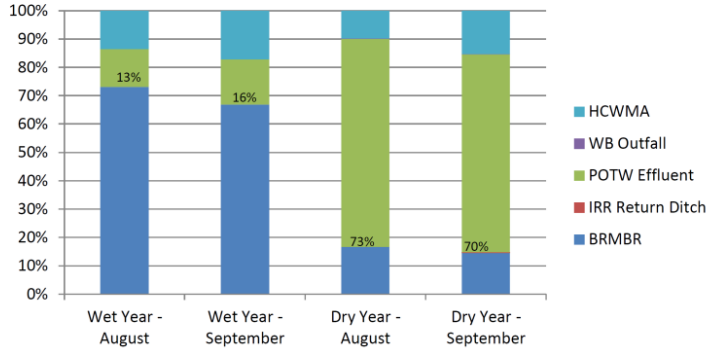
Max Plant Flows, Low TP Concentrations



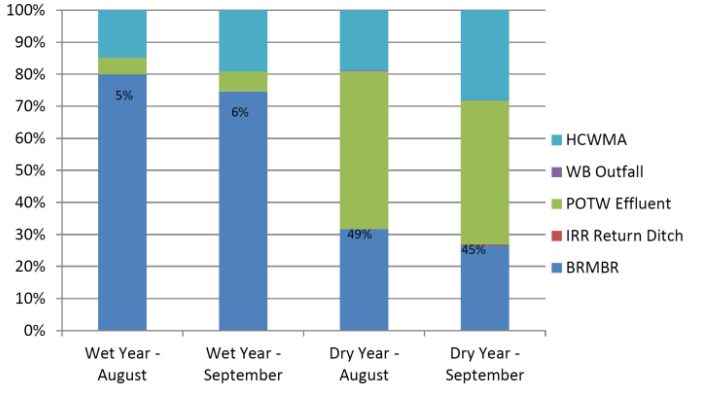
2012 Plant Flows, Medium TP Concentrations



Max Plant Flows, Medium TP Concentrations



2012 Plant Flows, High TP Concentrations



Max Plant Flows, High TP Concentrations